

# HYDRODYNAMICS, IONIZATION, X-RAY SPECTRA, AND THE SN-SNR CONNECTION

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*Cas A VLP meeting, NRL, May 6 2004*

*Carles Badenes*

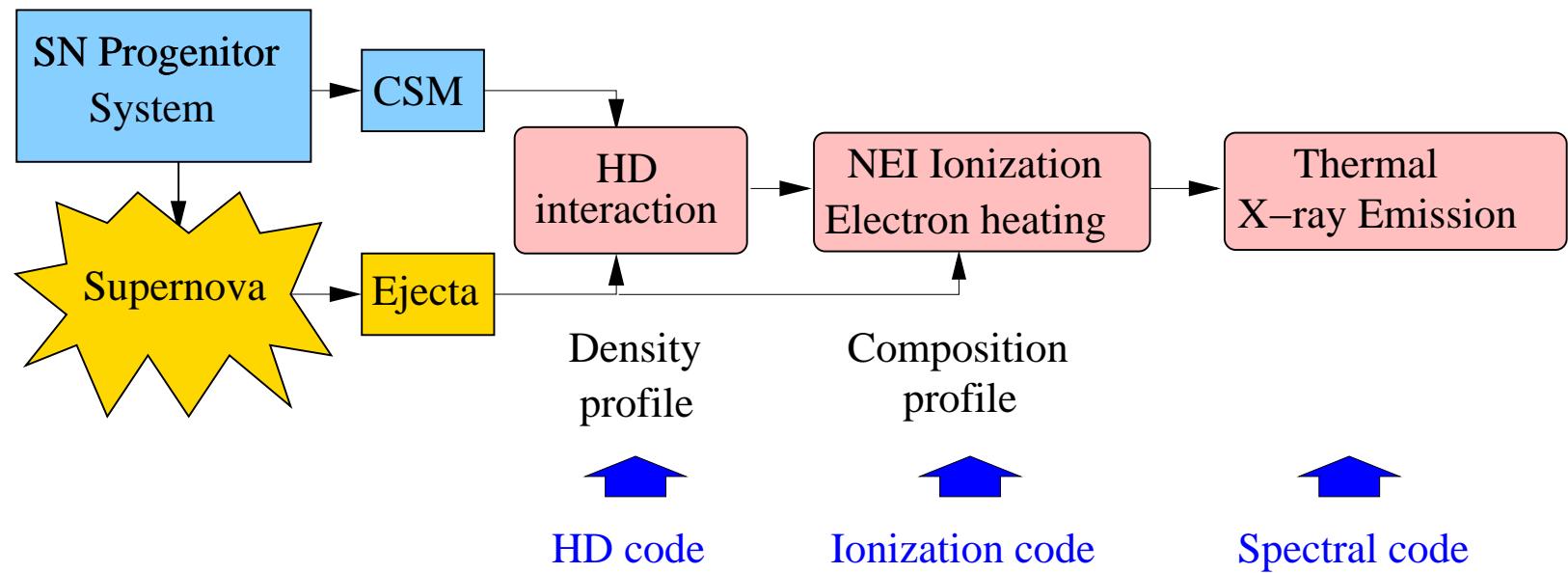
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# The Big Picture

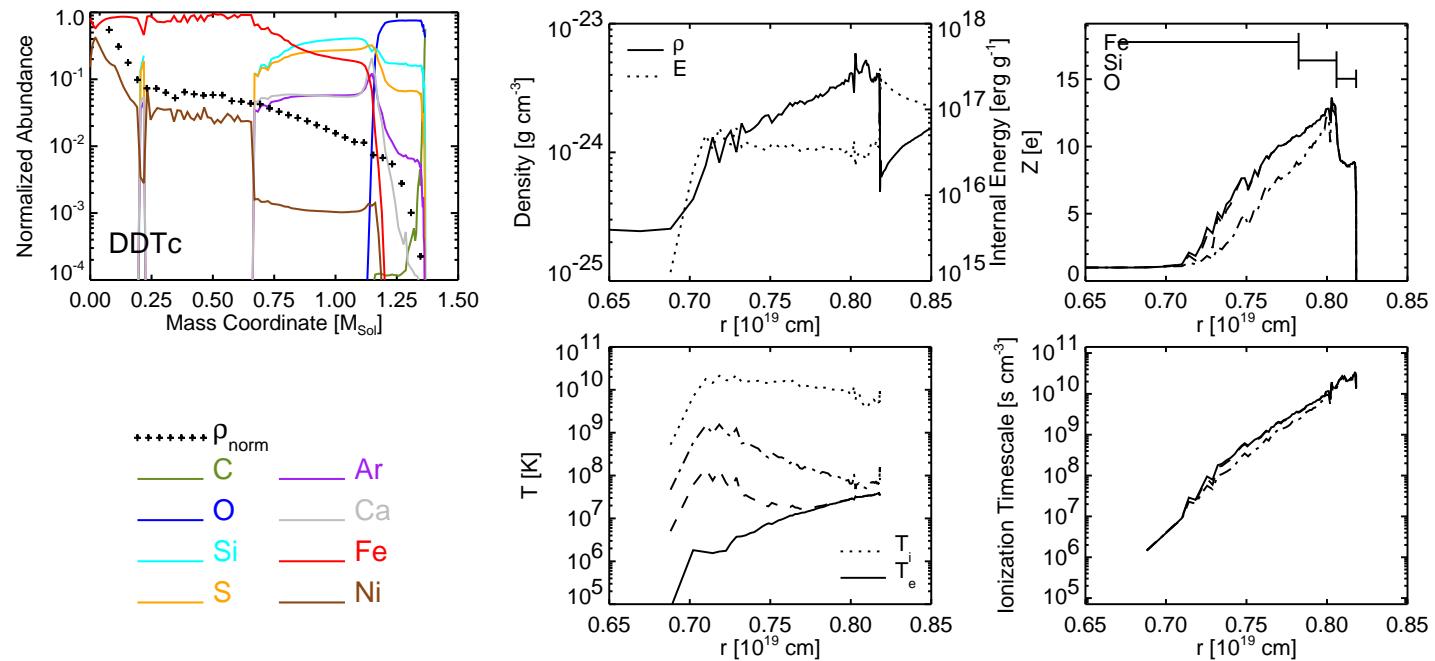
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# An Example in 1D: Modeling the Tycho SNR (I)

Model DDTc interacting with  $\rho_{AM} = 2 \cdot 10^{-24} \text{ g} \cdot \text{cm}^{-3}$

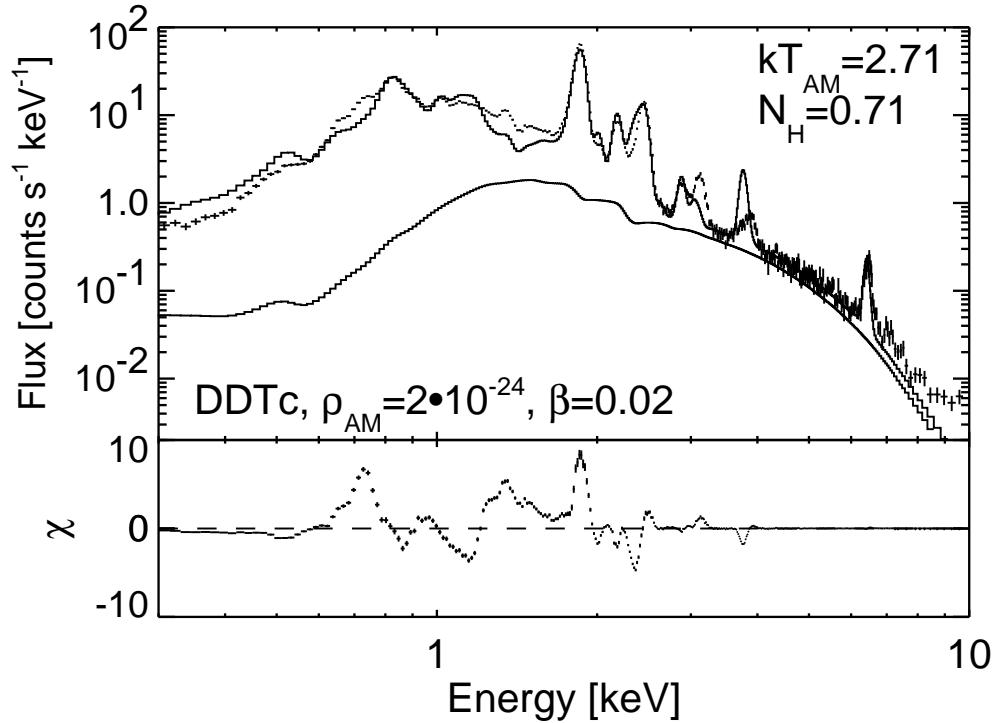
NEI ionization in the ejecta calculated with  $\beta = T_e/T_i = 0.0, 0.01, 0.1$



## An Example in 1D: Modeling the Tycho SNR (II)

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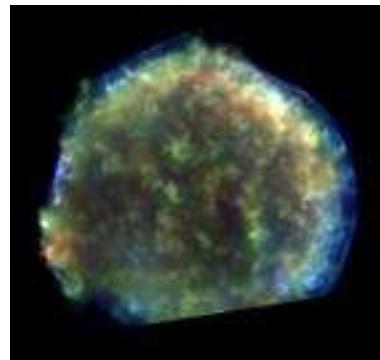
... et voilà:



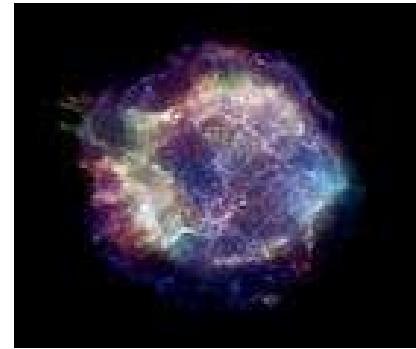
Not bad considering the limitations of the models, but **THIS IS NOT A FIT!!!!!!**

## One step beyond: modeling Cas A (I)

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vs.



- The structure of Cas A is much more complex. **Adiabatic 1D hydrodynamics are clearly inadequate.**
- **Initial conditions:** structure of the CSM (BSG-RSG wind?); structure of the core-collapse explosion (asymmetry? ejecta overturn?).
- **SNR evolution:** radiative cooling, ejecta clumping, instabilities.

## One step beyond: modeling Cas A (II)

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A 'global' model for Cas A is a project for the future. The techniques of LH and HL constitute a much better strategy for producing results from the VLP. It is certainly possible to take those techniques further:

- [Synthetic spectra](#) can easily be produced from the output of the BLASPHEMER code. The comparison of these spectra with the data might not be so easy.
- Analytic hydrodynamics (i.e., extended Truelove & McKee solutions) can be substituted by [numerical hydrodynamics](#) in 1D or multi-D:
  - ⇒ Explore other density profiles in 1D, both for ejecta and CSM.
  - ⇒ A multi-D study of hydrodynamics, NEI ionization and the formation of spectra can help to understand the structures (clumps and knots) that are seen on the *Chandra* images.
  - ⇒ Some degree of sophistication is required to study the structure of the jets.